PRIMEAU FORENSICS
IDENTIFY – CLARIFY – TESTIFY

15 October 2015

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[redacted]

I am an audio and video forensic expert and have been practicing for over 30 years. I have testified in several courts throughout the United States and worked on various international cases. My forensic practices for audio investigation include digital and analogue audio authentication, restoration and voice identification. As a video forensic expert, my practices include video authentication, restoration and identification.

On or about June 1st, 2015, I received a USB thumb drive containing 6 video files from your office. All six video files are in the MOV format. The files are as listed:

- **IMG_0591.MOV**
- **IMG_0592.MOV**
- **IMG_0593.MOV**
- **IMG_0594.MOV**
- **IMG_0595.MOV**
- **IMG_0596.MOV**

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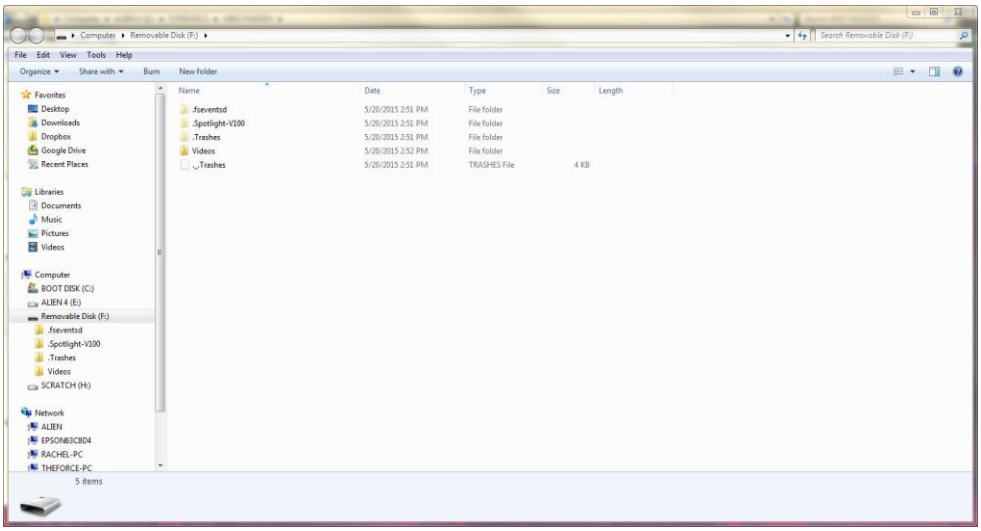
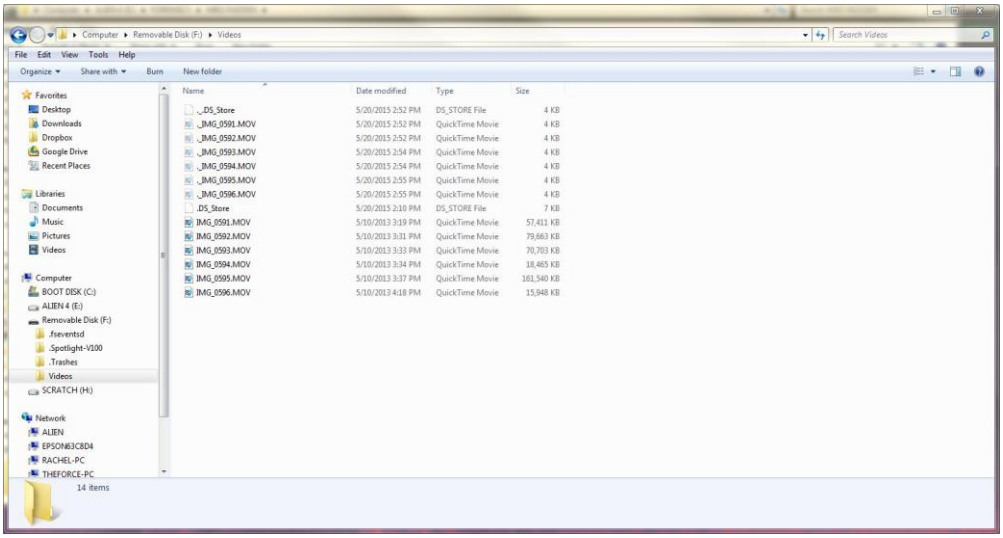
The contents of the thumb drive and the contents of the folder on the thumb drive are shown below:



Contents of Thumb Drive



Contents of Folder on Thumb Drive

I was asked to authenticate and clarify the audio content of **IMG_0592.MOV**. Forensic Authentication is the process of determining whether or not a recording is an original or an exact copy of the original recording that was created and accurately represents the events as they occurred. The analysis process involves

critical listening analysis, visual analysis of the waveform and spectrogram, and a digital information analysis.

Forensic Audio Clarification is the process of using non-destructive signal processors to make dialogue and events within an audio recording more audible and intelligible. The signal processing used does not alter the events as they occurred, and is only used as a means of better understanding what occurred within the recording.

I began by making exact copies of the video files and transferred them to my forensic computer. I performed a hash test to ensure that the video files I transferred were bit-for-bit copies of the original video files I received. The hash test is shown below:

ORIGINAL		
MD5	SHA1	FileNames
e339d0b652f53083913da696d3932bbf	15d0509175f12ed8503e03cc88bc929a9960f1e3	Videos\.DS_Store
285c773512542e09f01a5832cc1b72ef	394a32c6aaf9c5b660d53245f5c6ebd0076a1bd1	Videos\._.DS_Store
50b24f5e62ada3bcf1d087c5b1cc75f5	0879c0f833a4851bd766e38d7fcebb97054ef476	Videos\IMG_0591.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	Videos\._IMG_0591.MOV
3cd29a21ba758e0eebcafa09fef5098c	b9b70f6846223d29c6bc68d4a3e8887d4c7ebec0	Videos\IMG_0592.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	Videos\._IMG_0592.MOV
40341f2442f2b5e36c1e2a7a40360dbd	2c2cadc55b98682a53a4804055caecfbe68713d8	Videos\IMG_0593.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	Videos\._IMG_0593.MOV
d723bae2dbe67022f97cda9f1f8cd3c1	f44907ebdcc9b9cd3e479890b2297a443b105f87	Videos\IMG_0594.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	Videos\._IMG_0594.MOV
d4be986a2575d0644c6de501f7b1d5f7	ca96d61f415bb9f413b4925c1129eb41fd0e4be5	Videos\IMG_0595.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	Videos\._IMG_0595.MOV
1956b0ea4b02e5113fbe128619361734	b9e83509f2a182637d8186e0b2fdf8aeee848b95	Videos\IMG_0596.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	Videos\._IMG_0596.MOV
COPIES		
MD5	SHA1	FileNames
e339d0b652f53083913da696d3932bbf	15d0509175f12ed8503e03cc88bc929a9960f1e3	ORIGINAL EVIDENCE\.DS_Store
285c773512542e09f01a5832cc1b72ef	394a32c6aaf9c5b660d53245f5c6ebd0076a1bd1	ORIGINAL EVIDENCE\._.DS_Store
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	ORIGINAL EVIDENCE\._IMG_0591.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	ORIGINAL EVIDENCE\._IMG_0592.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	ORIGINAL EVIDENCE\._IMG_0593.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	ORIGINAL EVIDENCE\._IMG_0594.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	ORIGINAL EVIDENCE\._IMG_0595.MOV
9dc47d91bf1eca489b30b36fb916b400	3c333acc2184018f8a12117b5c131a9c4ca72a9f	ORIGINAL EVIDENCE\._IMG_0596.MOV
50b24f5e62ada3bcf1d087c5b1cc75f5	0879c0f833a4851bd766e38d7fcebb97054ef476	ORIGINAL EVIDENCE\IMG_0591.MOV
3cd29a21ba758e0eebcafa09fef5098c	b9b70f6846223d29c6bc68d4a3e8887d4c7ebec0	ORIGINAL EVIDENCE\IMG_0592.MOV
40341f2442f2b5e36c1e2a7a40360dbd	2c2cadc55b98682a53a4804055caecfbe68713d8	ORIGINAL EVIDENCE\IMG_0593.MOV
d723bae2dbe67022f97cda9f1f8cd3c1	f44907ebdcc9b9cd3e479890b2297a443b105f87	ORIGINAL EVIDENCE\IMG_0594.MOV
d4be986a2575d0644c6de501f7b1d5f7	ca96d61f415bb9f413b4925c1129eb41fd0e4be5	ORIGINAL EVIDENCE\IMG_0595.MOV
1956b0ea4b02e5113fbe128619361734	b9e83509f2a182637d8186e0b2fdf8aeee848b95	ORIGINAL EVIDENCE\IMG_0596.MOV

Video Evidence Hash Test

As the hash test shows, the files I extracted are bit-for-bit copies of the files found on the thumb drive I received. The files were organized differently by the thumb drive and the forensic computer drive, but the files are still exact matches when looking at each individually. I used these copies for my analysis and clarification in order to maintain the quality of the original videos I received. After making exact copies of the video files, I extracted the audio from **IMG_0592.MOV** by using Adobe Audition. The extracted audio was saved as an uncompressed WAV file to maintain the highest quality possible. This audio was used during the Forensic Authentication process, as well as the Forensic Audio Clarification process.

Authentication

The forensic digital video authentication investigation determines the originality, authenticity and integrity of a video recording. Through this investigation, a video forensic expert determines whether a recording is an exact original or a bit for bit second generation copy. The investigation requires critical listening analysis, visual analysis of the waveform and spectrogram, and a digital information analysis.

When authenticating digital video evidence, I analyze both the audio and video portions of the recording. To do so, I will view the evidence as a whole and analyze the video and audio separately. Upon my initial viewing of **IMG_0592.MOV**, I did not find any anomalies that would suggest the video had been tampered with.

To complete a thorough analysis, I created three exemplar recordings using the same make and model iPod Touch that was used to create the original recordings.

- IMG_0001.MOV
- IMG_0002.MOV
- IMG_0003.MOV

Using Adobe Audition, I extracted the audio from the video files and saved the audio files as uncompressed WAV files. For this analysis, I used the audio from the IMG_0001.MOV and the IMG_0003.MOV recordings. These are referred to as **Comparison 1** and **Comparison 3** respectively.

Digital Format/Structure Analysis

For the digital format/structure information analysis, I analyze the metadata and hex information contained within the files. This is stored within the file and holds information regarding the quality, settings, and devices used to create the

recording. I use Adobe Audition, MediaInfo, WinHex, and HxD to analyze this information.

The metadata for **IMG_0592.MOV** is shown below:

```
General
Complete name                            : E:\FORENSICS\CASES\MIKE PADDEN\VIDEOS\ORIGINAL EVIDENCE\IMG_0592.MOV
Format                                   : MPEG-4
Format profile                           : QuickTime
Codec ID                                 : qt
File size                                : 77.8 MiB
Duration                                 : 1mn 2s
Overall bit rate                         : 10.5 Mbps
Recorded date                            : 2013-05-10T15:29:58-0500
Encoded date                             : UTC 2013-05-10 20:29:58
Tagged date                              : UTC 2015-07-06 21:26:28
Writing application                      : 5.1
Writing library                          : Apple QuickTime
Model                                    : iPod touch
Make                                     : Apple
```

IMG_0592 Metadata 1

```
Video
ID                                       : 1
Format                                   : AVC
Format/Info                              : Advanced Video Codec
Format profile                           : Baseline@L3.1
Format settings, CABAC                   : No
Format settings, ReFrames                : 1 frame
Format settings, GOP                     : M=1, N=30
Codec ID                                 : avc1
Codec ID/Info                            : Advanced Video Coding
Duration                                 : 1mn 2s
Source duration                          : 1mn 2s
Bit rate                                 : 10.4 Mbps
Width                                    : 1 280 pixels
Height                                   : 720 pixels
Display aspect ratio                     : 16:9
Frame rate mode                          : Variable
Frame rate                               : 29.970 fps
Minimum frame rate                       : 28.571 fps
Maximum frame rate                       : 31.579 fps
Color space                              : YUV
Chroma subsampling                       : 4:2:0
Bit depth                                : 8 bits
Scan type                                : Progressive
Bits/(Pixel*Frame)                       : 0.376
Stream size                              : 77.2 MiB (99%)
Source stream size                       : 77.3 MiB (99%)
Title                                    : Core Media Video
Encoded date                             : UTC 2013-05-10 20:29:58
Tagged date                              : UTC 2013-05-10 20:30:11
Color range                              : Limited
Color primaries                          : BT.709
Transfer characteristics                 : BT.709
Matrix coefficients                      : BT.709
```

IMG_0592 Metadata 2

```
Audio
ID                                       : 2
Format                                   : AAC
Format/Info                              : Advanced Audio Codec
Format profile                           : LC
Codec ID                                 : 40
Duration                                 : 1mn 2s
Source duration                          : 1mn 2s
Bit rate mode                            : Constant
Bit rate                                 : 64.0 Kbps
Channel(s)                               : 1 channel
Channel positions                        : Front: C
Sampling rate                            : 44.1 KHz
Compression mode                         : Lossy
Stream size                              : 488 KiB (1%)
Source stream size                       : 488 KiB (1%)
Title                                    : Core Media Audio
Encoded date                             : UTC 2013-05-10 20:29:58
Tagged date                              : UTC 2013-05-10 20:30:11
```

IMG_0592 Metadata 3

The metadata for **IMG_0592.MOV** revealed the following pertinent information:

- MPEG-4 format
- Apple Quicktime signature
- iPod touch signature
- Advanced Video Codec signature
- Variable video frame rate
- 1280 x 720 resolution
- Advanced Audio Codec signature
- Constant audio bit rate
- 64 Kilobits per second
- 1 channel (mono)
- 44.1kHz sample rate
- 2013-05-10 encoded date

The metadata for **Comparison 1** is shown below:

```
General
Complete name                            : E:\FORENSICS\CASES\MIKE PADDEN\VIDEOS\TEST VIDEOS\IMG_0001.MOV
Format                                   : MPEG-4
Format profile                           : QuickTime
Codec ID                                 : qt
File size                                : 20.4 MiB
Duration                                 : 15s 813ms
Overall bit rate                         : 10.8 Mbps
Recorded date                            : 2015-07-29T09:46:09-0700
Encoded date                             : UTC 2015-07-29 16:46:09
Tagged date                              : UTC 2015-07-29 16:46:22
Writing application                      : 6.1.6
Writing library                          : Apple QuickTime
Model                                    : iPod touch
Make                                     : Apple
com.apple.quicktime.make                 : Apple
com.apple.quicktime.creationdate         : 2015-07-29T09:46:09-0700
com.apple.quicktime.software             : 6.1.6
com.apple.quicktime.model                : iPod touch
```

Comparison 1 Metadata 1

```
Video
ID                                       : 1
Format                                   : AVC
Format/Info                              : Advanced Video Codec
Format profile                           : Baseline@L3.1
Format settings, CABAC                   : No
Format settings, ReFrames                : 1 frame
Format settings, GOP                     : M=1, N=30
Codec ID                                 : avc1
Codec ID/Info                            : Advanced Video Coding
Duration                                 : 15s 813ms
Source duration                          : 15s 835ms
Bit rate                                 : 10.8 Mbps
Width                                    : 1 280 pixels
Height                                   : 720 pixels
Display aspect ratio                     : 16:9
Frame rate mode                          : Variable
Frame rate                               : 28.102 fps
Minimum frame rate                       : 24.000 fps
Maximum frame rate                       : 30.000 fps
Color space                              : YUV
Chroma subsampling                       : 4:2:0
Bit depth                                : 8 bits
Scan type                                : Progressive
Bits/(Pixel*Frame)                       : 0.416
Stream size                              : 20.3 MiB (99%)
Source stream size                       : 20.3 MiB (99%)
Title                                    : Core Media Video
Encoded date                             : UTC 2015-07-29 16:46:09
Tagged date                              : UTC 2015-07-29 16:46:22
Color range                              : Limited
Color primaries                          : BT.709
Transfer characteristics                 : BT.709
Matrix coefficients                      : BT.709
```

Comparison 1 Metadata 2

```
Audio
ID                                       : 2
Format                                   : AAC
Format/Info                              : Advanced Audio Codec
Format profile                           : LC
Codec ID                                 : 40
Duration                                 : 15s 812ms
Source duration                          : 15s 859ms
Bit rate mode                            : Constant
Bit rate                                 : 64.0 Kbps
Channel(s)                               : 1 channel
Channel positions                        : Front: C
Sampling rate                            : 44.1 KHz
Compression mode                         : Lossy
Stream size                              : 124 KiB (1%)
Source stream size                       : 124 KiB (1%)
Title                                    : Core Media Audio
Encoded date                             : UTC 2015-07-29 16:46:09
Tagged date                              : UTC 2015-07-29 16:46:22
```

Comparison 1 Metadata 3

The metadata for **Comparison 1** revealed the following pertinent information:

- MPEG-4 format
- Apple Quicktime signature
- iPod touch signature
- Advanced Video Codec signature
- Variable video frame rate
- 1280 x 720 resolution
- Advanced Audio Codec signature
- Constant audio bit rate
- 64 Kilobits per second
- 1 channel (mono)
- 44.1kHz sample rate

As the metadata comparison shows, the file formats are consistent between **IMG_0592.MOV** and **Comparison 1**. The only differences that can be seen in this information is the frame rate of the videos, which is due to the variable frame rate setting as listed above.

The images below show the hex information for **IMG_0592.MOV**:

```
03 D1 EF 23  ¶ è ¿ï‰ ÈO  Ñï♯
03 F6 42 CD  ÚUö ãç- ìQ/ öBÍ
04 1C 1B 55  ÿ{û  l*  ‰    U
04 41 0D BE  $'1 .|B 6ÜW A ¾
04 66 A6 C8  Iv  SÏm \;Z f¦È
04 8C EA 01  o c yn4  è  Œê
04 B5 AA 06  -`2 ¡¡O ª00 µª
A9 6D 6F 64    budta    ©mod
63 68 00 00    ÇiPod touch
31 00 00 00   ©swr   Ç5.1
33 2D 30 35 $©day   Ç2013-05
2D 30 35 30 -10T15:29:58-050
C7 41 70 70 0    ©mak   ÇApp
00 00 00 00 le    free
00 00 00 00
00 00 00 00
```

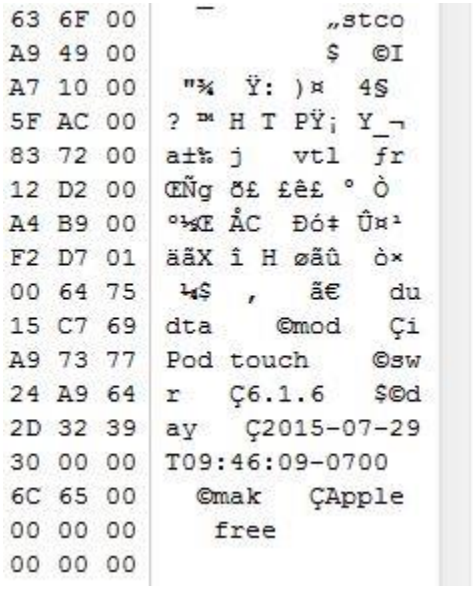
IMG_0592 Hex Analysis 1

```
00 00 00 00
00 22 68 64      Ymeta   "hd
74 61 00 00 lr        mdta
00 00 00 9D
00 00 00 20 keys
65 2E 71 75 mdtacom.apple.qu
00 00 00 28 icktime.make   (
65 2E 71 75 mdtacom.apple.qu
74 69 6F 6E icktime.creation
63 6F 6D 2E date   $mdtacom.
69 6D 65 2E apple.quicktime.
6D 64 74 61 software   !mdta
69 63 6B 74 com.apple.quickt
92 69 6C 73 ime.model   'ils
15 64 61 74 t            dat
6C 65 00 00 a    US ÇApple
74 61 00 00  0       (data
35 2D 31 30   US Ç2013-05-10
30 30 00 00 T15:29:58-0500
74 61 00 00          data
22 00 00 00   US Ç5.1   "
01 55 53 15      data    US
00 04 00 66 ÇiPod touch    f
00 00 00 00 ree
00 00 00 00
```

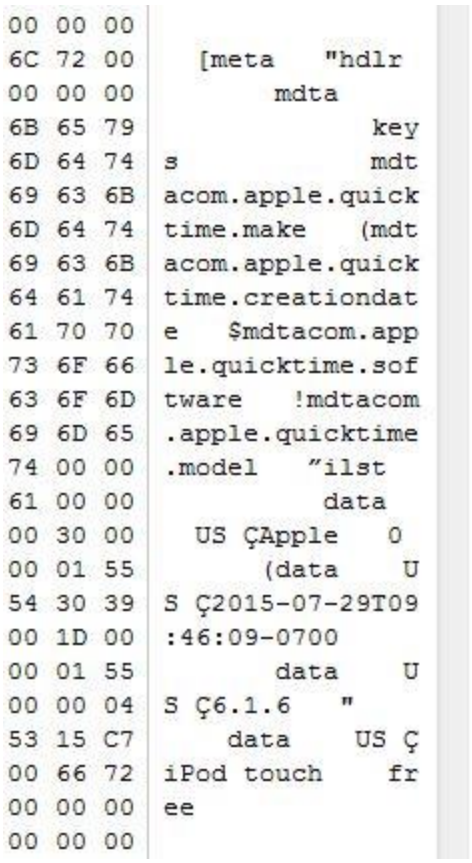
IMG_0592 Hex Analysis 2

As the images show, there are various signatures showing that the video was made using an Apple iPod Touch device. I did not find any other signature from software or other devices. If the video had been opened in editing software, this would be visible within the hex information.

The images below show the hex information from the comparison recording:



Comparison Hex Analysis 1



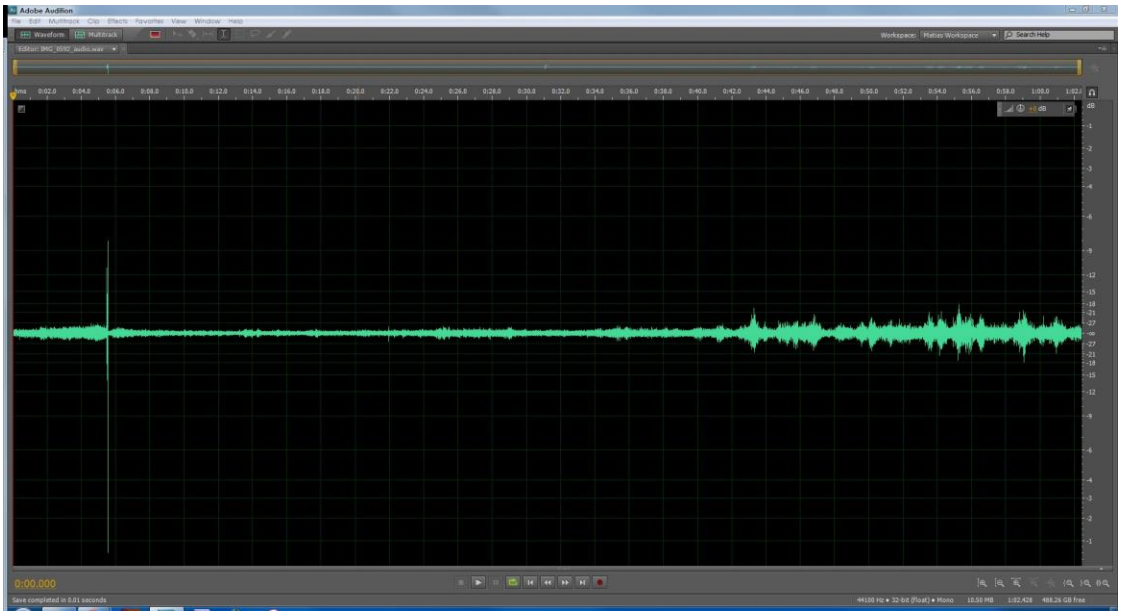
Comparison Hex Analysis 2

As these images show in comparison with the hex information found in **IMG_0592.MOV**, both video files have the same signatures signifying that an Apple iPod Touch created them.

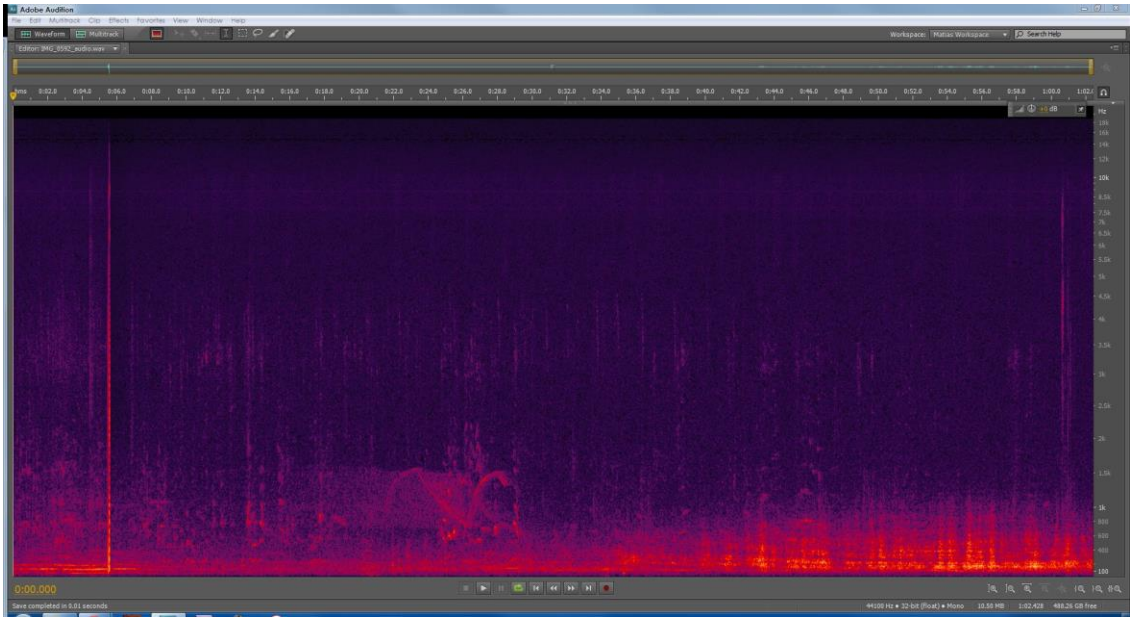
Digital Measurement Analysis of Audio Information

For the measurement analysis, I analyze the waveform, spectrogram, spectrum, and power of the audio recording. To complete this analysis, I use Adobe Audition, iZotope RX4 Advanced, and WaveSurfer.

The waveform view and spectrogram view of **IMG_0592.MOV** are shown below:



IMG_0592 Waveform Analysis

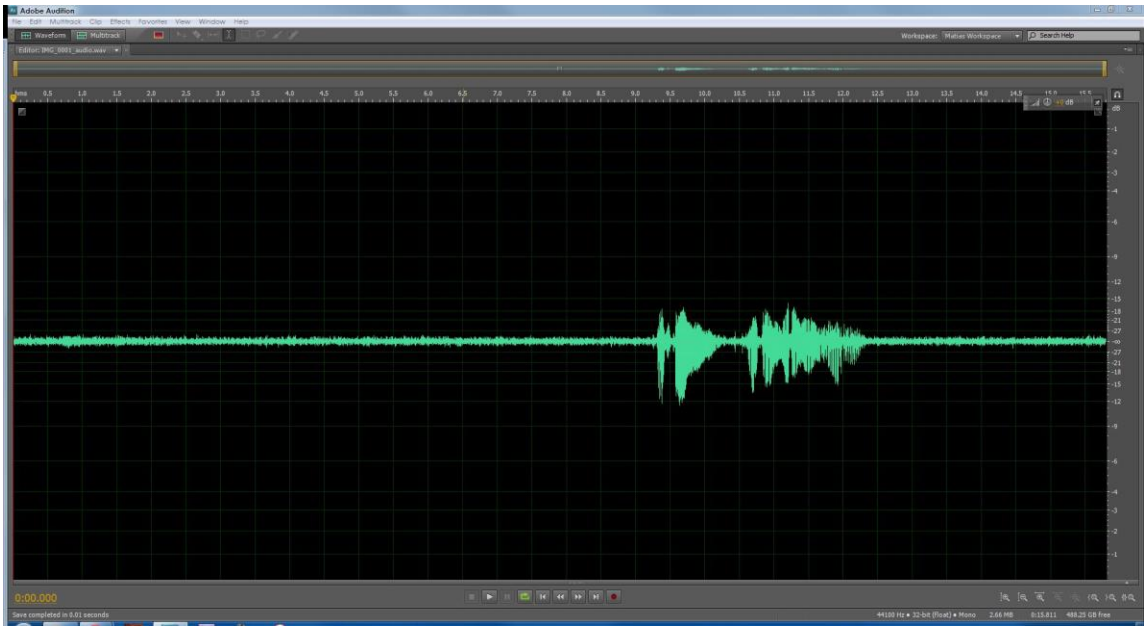


IMG_0592 Spectrogram Analysis

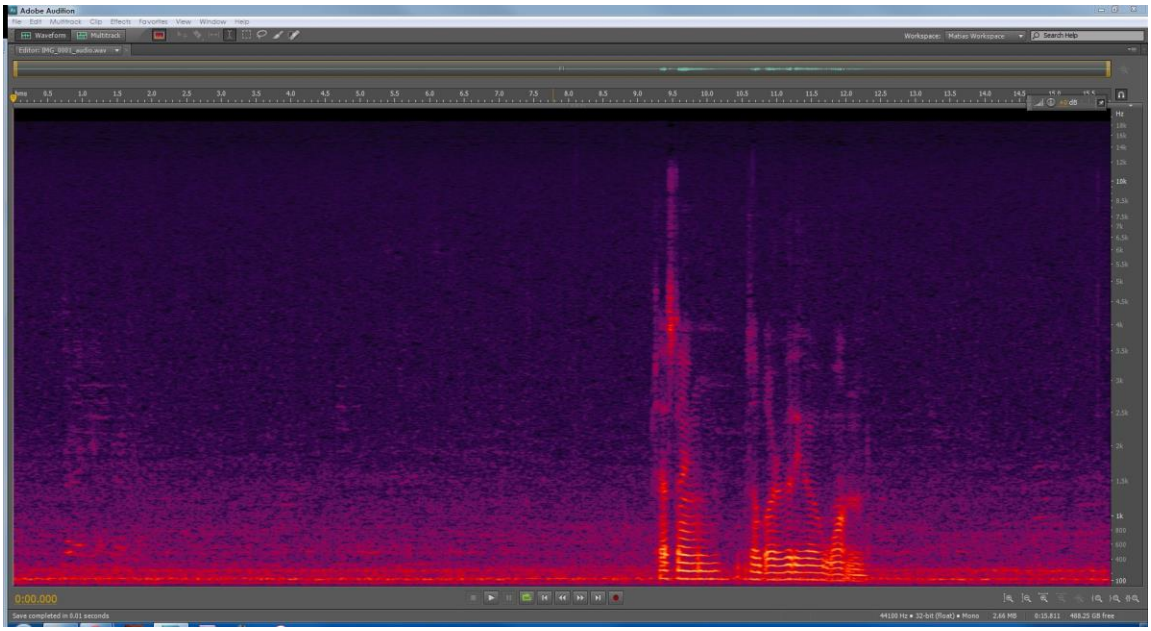
The noise floor can be seen in the spectrogram as the dark purple present throughout the recording. The noise floor is the sum of all extraneous noise in a recording, including any background noise and any noise created by the device itself. The consistent noise floor throughout the recording suggests that no edits

have been made. The waveform is also continuous throughout the recording and does not show any signs of tampering.

For further comparison, I analyzed the comparison files I created using the iPod Touch I obtained for the case. The waveform and spectrogram view for **Comparison 1** are shown below:

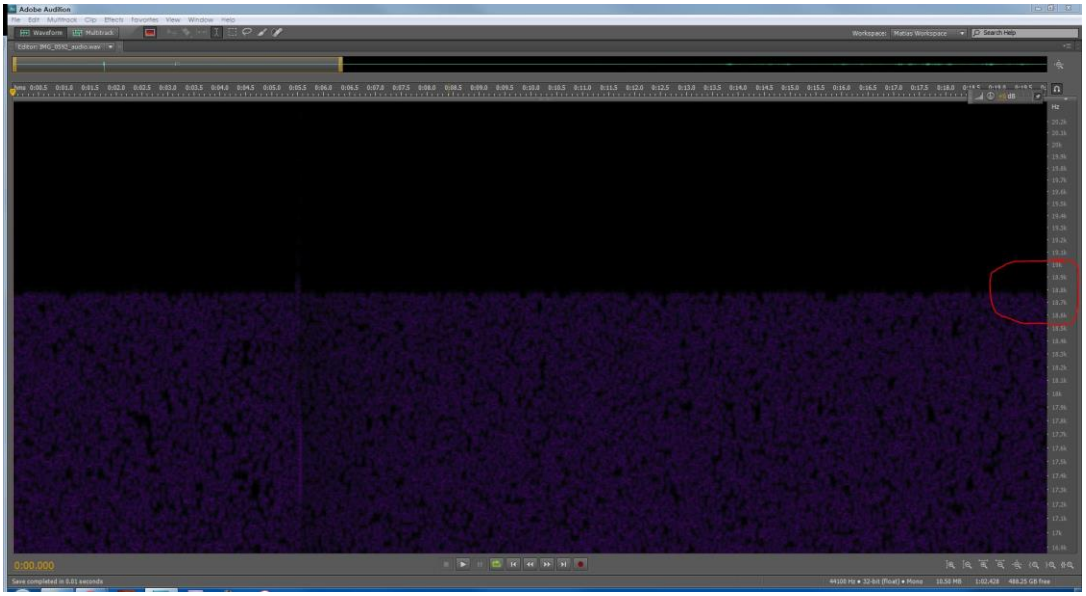


Comparison 1 Waveform Analysis

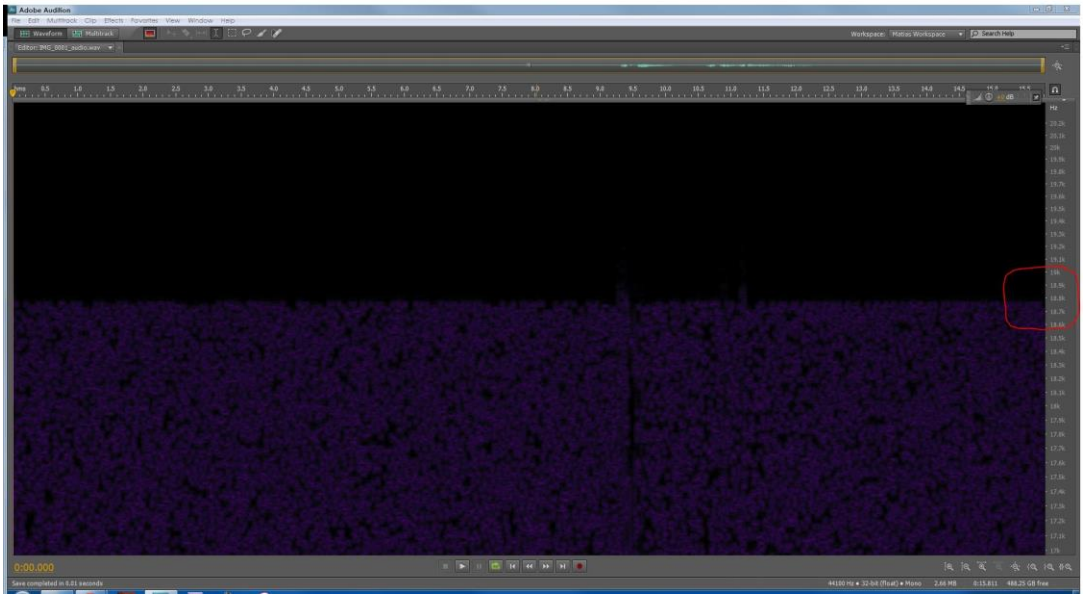


Comparison 1 Spectrogram Analysis

As the **Comparison 1** images show, the noise floor, as well as base noise level, are almost identical between the recordings. Upon closer analysis of the spectrogram view, the high frequency cutoff can be seen. The images below show a close spectrogram view of the audio from **IMG_0592.MOV** and the audio from **Comparison 1**:



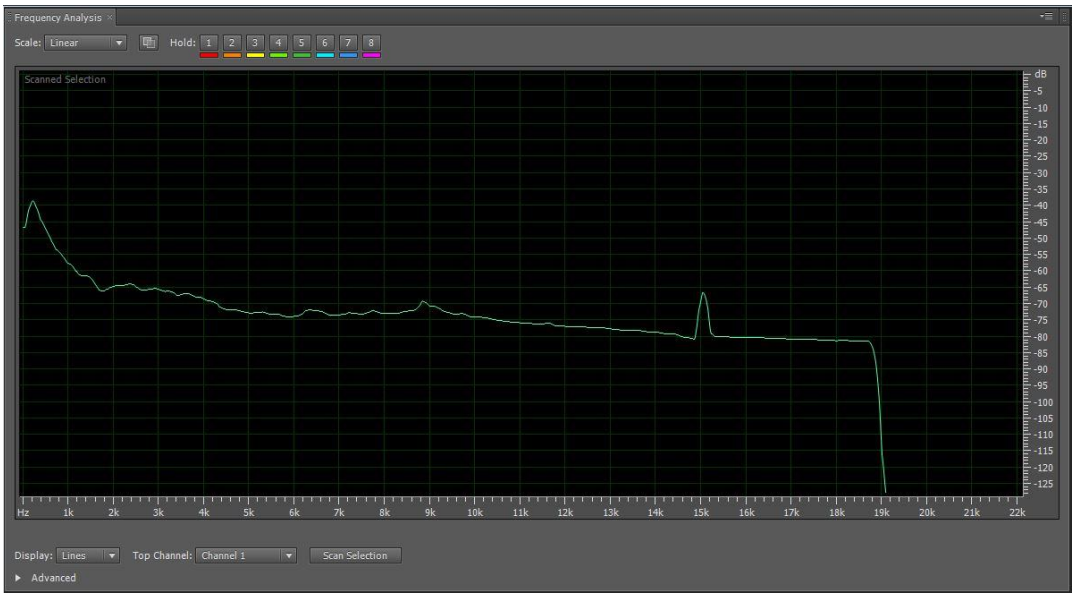
IMG_0592 Spectrogram High Frequency Cutoff



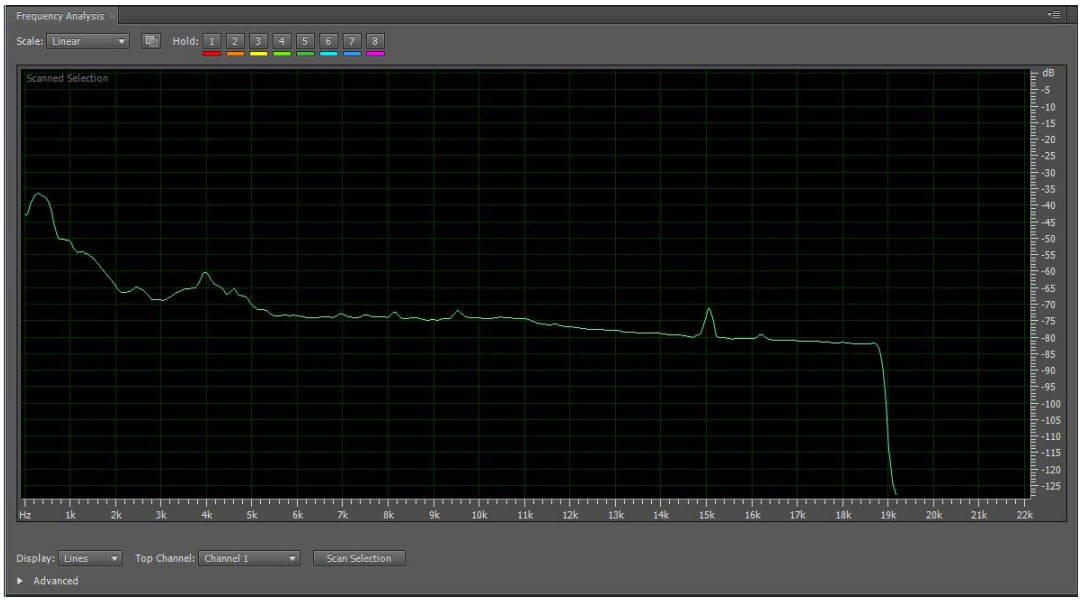
Comparison 1 Spectrogram High Frequency Cutoff

As the images show, both recordings have a high frequency cutoff of roughly 18800 Hz (18.8 kHz). This shows consistency in both the quality and recording characteristics of the device and supports the conclusion that **IMG_0592.MOV** was created using an iPod Touch and was not tampered with after its creation.

The images below show the spectrum analysis of **IMG_0592.MOV** and **Comparison 1**:



IMG_0592 Spectrum Analysis



Comparison 1 Spectrum Analysis

The spectrum shows the overall frequency content of the audio recording. Frequency is shown on the x axis and amplitude is shown on the y axis. As the two

images show, **IMG_0592.MOV** and **Comparison 1** are consistent with respect to cutoff frequency and overall slope. A boost in frequency content can be seen at 15 kHz in both spectrums, which is most likely an inherent characteristic of the recording device. This characteristic in **IMG_0592.MOV** is consistent with an original iPod Touch video recording.

The images below show the beginning portion of the waveform for **IMG_0592.MOV** and **Comparison 1**:

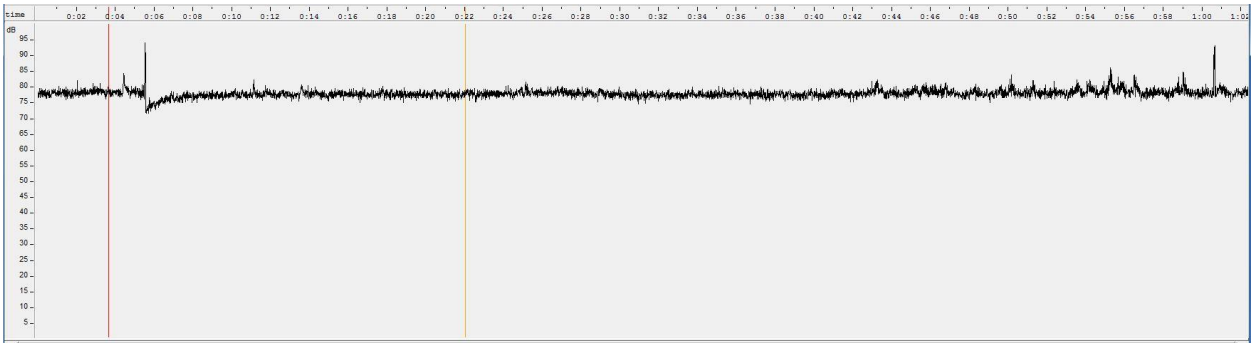
IMG_0592 Waveform Analysis

Comparison 1 Waveform Analysis

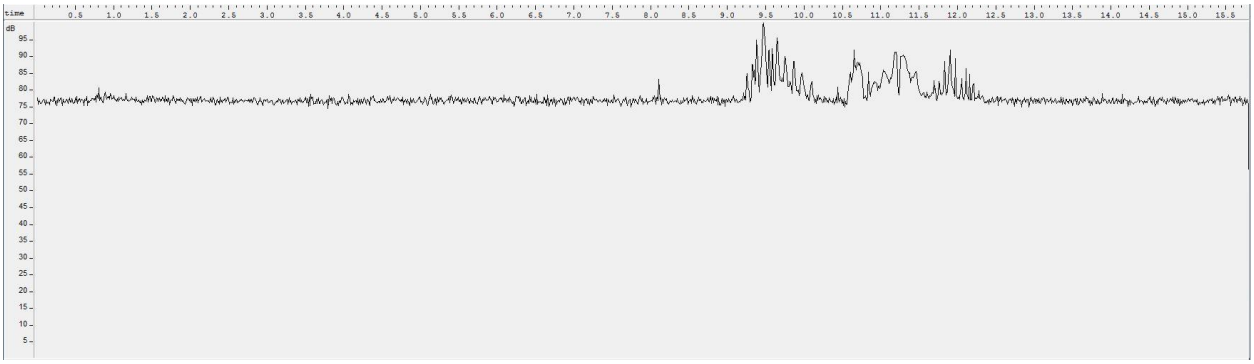
These views are close zooms on the beginning of each waveform to show the individual sample values that make up the digital audio file. Time is represented on

the x axis and sample value is represented on the y axis. When a file is resaved and compressed, it will often alter the file and cause the audio to begin with a series of 0 value samples. **IMG_0592.MOV** does not begin with any 0 value samples and is consistent with the audio from **Comparison 1**. This characteristic in **IMG_0592.MOV** is consistent with an original iPod Touch video recording.

The images below show the power plot for **IMG_0592.MOV** and **Comparison 1**:



IMG_0592 Power Plot Analysis



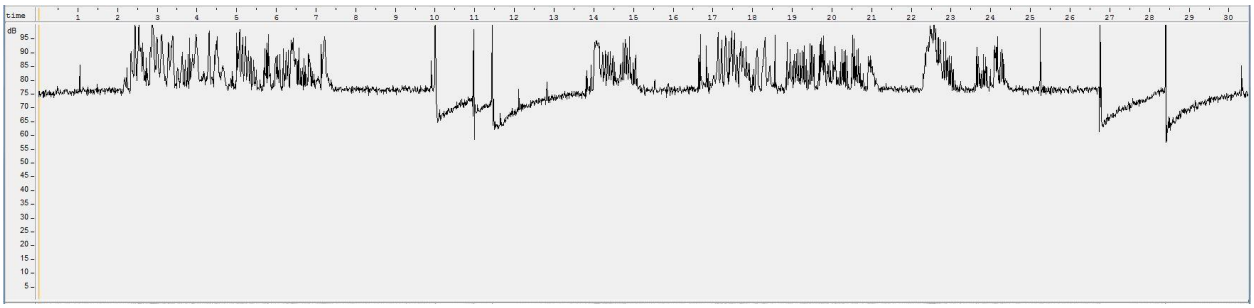
Comparison 1 Power Plot Analysis

The above images display the power over time within the recordings, with time on the x axis and power in decibels on the y axis. As the image shows, **IMG_0592.MOV** has a continuous average power level that is consistent with **Comparison 1**. There are no breaks or anomalies that would suggest that **IMG_0592.MOV** was tampered with.

There is a small dip in the power level around 0:05 in **IMG_0592.MOV**. This is due to the device being hit and an automatic gain setting attenuating the input level. The gain then gradually increases back to its original level. The time it takes for the input to reach its original level after attenuation is about two seconds. For

reference, I compared the evidence with **Comparison 3** in which I performed the same action of hitting the device to initiate the automatic gain control.

The power plot for **Comparison 3** is shown below:



Comparison 3 Power Plot Analysis

As the image shows, when the device was hit, the gain is attenuated. The time it took for the gain to reach its original level was roughly two seconds. This automatic gain control characteristics are consistent with an original recording made on an iPod Touch.

Critical Listening

In order to complete an audio authentication, I carefully listen through the audio recording multiple times to become familiar with it. I will note any characteristics of the recording, as well as any anomalies that I hear. Such anomalies would be audible as jumps in the sound, disturbances in the noise floor and sudden changes in level that could not be explained by movement within the video. I will then analyze these points in conjunction with my visual and digital analysis.

When listening to the audio separately from the video, I did not hear any anomalies that would suggest an edit or that tampering had occurred. The audio is continuous throughout the recording and is consistent with digital audio recordings I have analyzed in the past.

I then critically listened to **Comparison 1** to compare the audible characteristics with **IMG_0592.MOV**. I found the audio in both files to have the same sound characteristics in terms of quality of the audio and amount of internal noise introduced by the device. I found no differences in terms of audio quality between the recordings based on my auditory analysis.

Authentication Conclusion

Based on my critical listening analysis, visual analysis of the waveform and spectrogram, and digital information analysis, I conclude beyond a reasonable degree of scientific certainty that the video **IMG_0592.MOV** is consistent with an original video and that it accurately represents the events as they occurred.

Clarification

An audio clarification is done to increase the intelligibility of the audio in a recording so that one can better understand the events as they occurred. Clarified versions of the audio are to be used in conjunction with the original audio when submitted to the court. When clarifying the audio for **IMG_0592.MOV**, I used forensically accepted audio signal processing tools that did not alter the events as they occurred within the video.

Our clarification process follows both SWGDE Best Practices as well as our own Standard Operating Procedures for Audio Clarification. At Primeau Forensics, we use Adobe Audition and iZotope RX4 Advanced to perform forensic audio clarifications. These are both approved and accepted software in the forensic community.

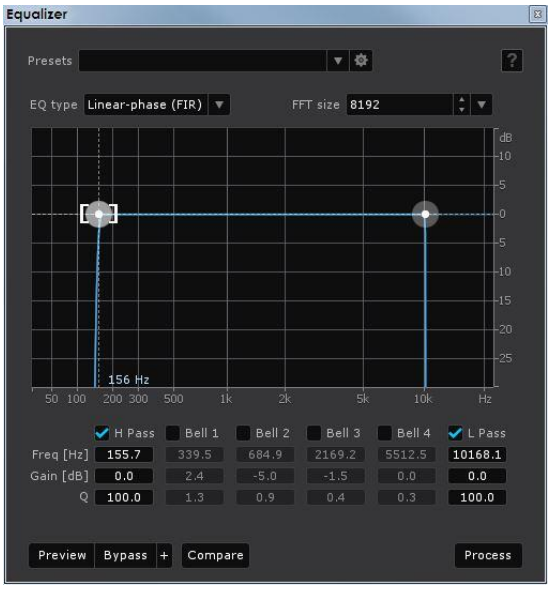
I began the clarification process by critically listening to the recording to identify problems with the recording. When I first listened to the audio, I detected the sound of a plane flying overhead in the last portion of the audio. For this reason, I processed the last portion of the audio differently than the beginning in order to best address noise content. This was done on the first version of the clarification.

We completed three versions of the clarification using different processors and settings to be used together to better understand the events as they occurred. The signal processors we used included:

- Noise Reduction
- Multiband Compression
- Equalization
- High Pass/Low Pass Filters
- Notch Filters
- Tube-modeled Compression
- Gain Adjustment

My findings below were found while specifically referencing **IMG_0592_Clarification_1.wav**. The following steps and images show the specific processing that was used for this file:

1. I began with a high pass filter and low pass filter combination to eliminate noise outside of the specified range (155.7 Hz to 10168.1 Hz). This range was set based on the spectrogram analysis and critical listening.



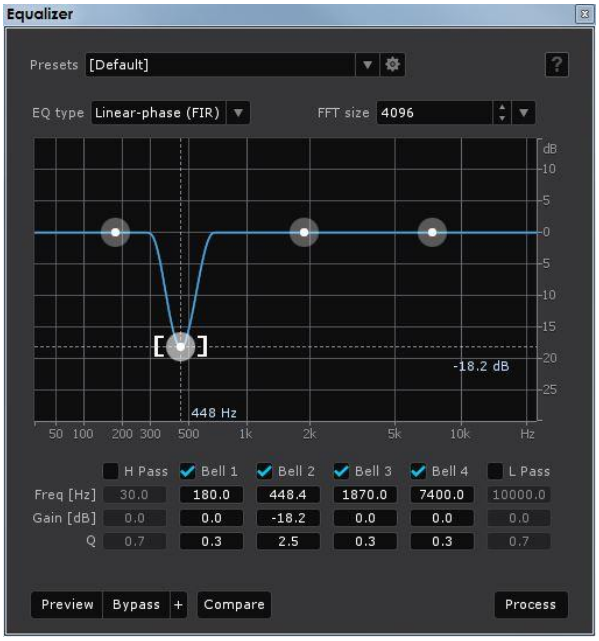
High Pass Filter/Low Pass Filter

2. I used a denoiser to remove other noise content within the same frequency range of the dialogue. This was done in two passes at smaller amounts of reduction to minimize the amount of artifacts introduced and increase the effectiveness of the processor.

Denoiser 1

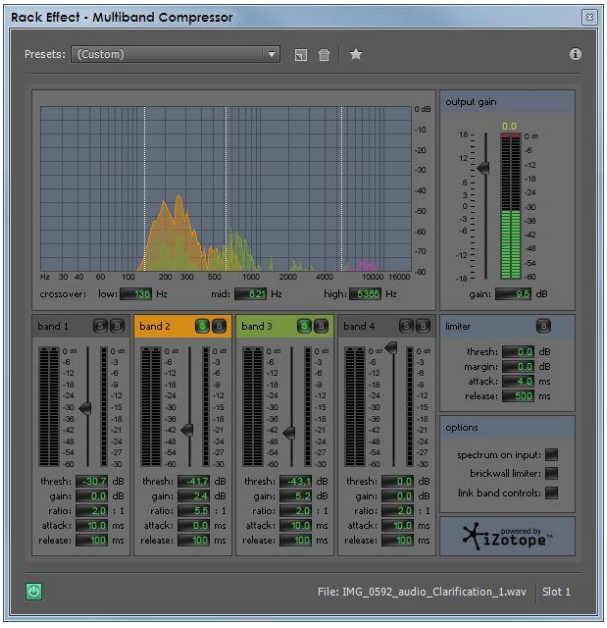
Denoiser 2

3. I used a notch filter to remove a narrow band of frequencies centered around 448.4 Hz during the end portion of the audio (0:42 - end). This frequency range mainly contained the noise of the plane and did not contain dialogue.



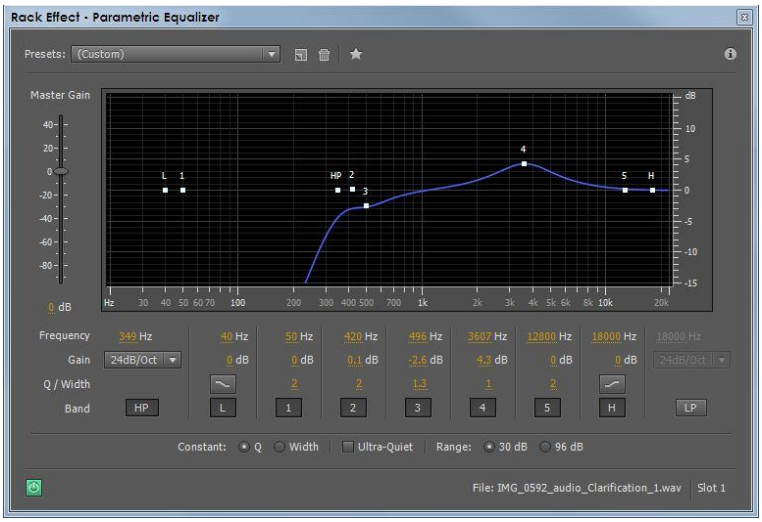
Notch Filter

4. I used a multiband compressor to increase the level of some frequencies while compressing others. I also used this to further eliminate high and low frequency noise outside of the specified range (136 Hz to 5365 Hz).



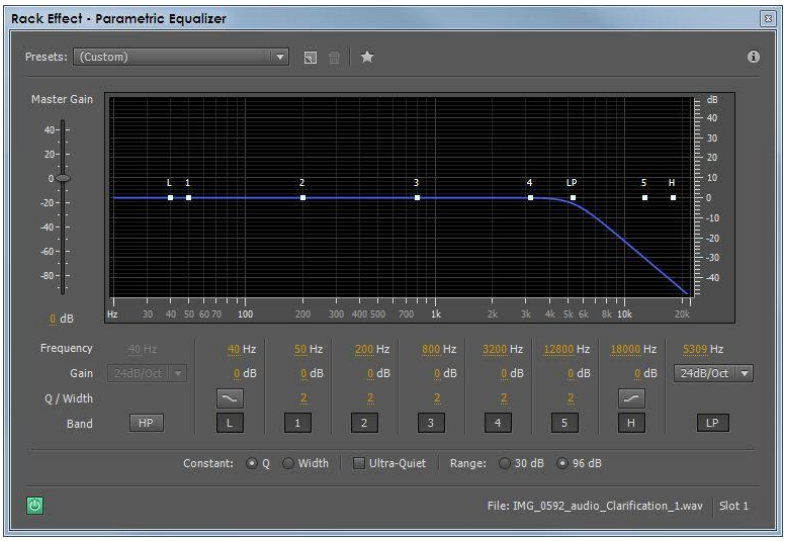
Multiband Compressor

5. I used an equalizer to further decrease the noise of the plane and boost the dialogue in the end portion of the audio (0:42 - end). The equalizer removed lower frequencies and boosted some frequencies in the "high-mid" range where voice content is most present.



Equalizer

6. I used another low pass filter to further remove high frequency noise. This was done with a smoother slope to avoid creating further artifacts.



Low Pass Filter

I referenced the audio enhancements when creating the following transcript that were recorded across the street on the iPod Touch. Other witnesses in the area that heard the altercation may have interpreted the dialogue transcribed below differently for the following reasons:

- Emotional effect on recollection (fear and stress factors)
- Active vs Passive Listening (level of attention to the events occurring)
- Physical or body limitations to sound perception (hearing ability, wax build up)
- Physical barriers between events and witnesses (windows, doors, open/closed)

The following transcript represents my perception of the background ambience and dialogue spoken during the recording in video **IMG_0592.MOV** using critical listening skills. I have found the following opinions regarding content of the dialogue spoken; all voices heard appear to be live and consistent throughout the audio and are not prerecorded:

- 0:08 - "(Unintelligible)...My name is Mookie"
- 0:11 - "(Unintelligible)...45-9 (Unintelligible) Officer Shot"
- 0:13 - "(Unintelligible)...Ask him where he was shot"
- 0:15 - "(Unintelligible)...Get out of here"
- 0:17 - "(Unintelligible)"
- 0:18 - "*(Sirens heard for the first time)*
- 0:24 - "(Unintelligible)...pretty good'
- 0:26 - "Damn freakin'… (unintelligible)."
- 0:27 - "(Unintelligible)...Let me go"
- 0:29 - "In the alley"
- 0:38 - "Stand up"
- 0:43 - "Come out (unintelligible)...put those hands up now"
- 0:49 - "(Unintelligible)"

Exemplar

After creating the three enhancements, I believed that I heard gunshots at the 00:53 timecode marker in the Gaines recording titled "IMG_0592.MOV". Working with a reasonable hypothesis for comparison, I flew to Minnesota in August of 2015 to perform further audio analysis and investigation at the home where the altercation occurred.

My goal while on location was to observe the surrounding area and create an audio exemplar so I could reach a definitive answer regarding the uncertainty of the presence of gunshots in the original audio evidence titled "IMG_0592.MOV". I familiarized myself with the home and its surrounding property and reached a comfortable medium with the acoustics of the area.

The testing results regarding the presence of gunshots were inconclusive as a result of:

- The existence of sounds present during the exemplar recording that did not take place during the original event documented in the Gaines recording.
- Conflicting testimony of eye witnesses and their positioning during the altercation.

My ultimate goal while in Minnesota was to confidently reinforce my opinions expressed within this forensic report using scientific testing on site.

Conclusion

In conclusion, Gaines recording of file **IMG_0592.MOV** is an accurate representation of the altercation that it depicts. The three enhancement work product files that are attached to this report will aid the court in understanding the dialogue spoken that I have outlined above to the best of my ability.

Based on the quality of the audio, a voice identification analysis could not be performed. A voice identification analysis requires a minimum of 10 to 20 words spoken and enough frequency content for a thorough analysis. This audio recording did not contain enough spoken words from each individual and did not meet the standards for a thorough voice identification.

I reserve the right to amend my conclusions and opinions as additional materials are provided in conjunction with future testimony.

Respectfully,

Edward J Primeau, CCI, CFC